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(54) MATERIAU MIXTE LAMINE BIODEGRADABLE, A BASE DE MOUSSE D'AMIDON RETICULEE; METHODE DE PREPARATION

(54) BIODEGRADABLE LAMINATED COMPOSITE MATERIAL BASED ON CURED STARCH FOAM AND METHOD FOR PREPARING IT

(57)

There is provided biodegradable laminated composite material based on cured starch foam and a method for preparing it. During the preparation the starch foam is simultaneously combined with an additional layer of a further material. The advantages of the invention include the simple and cost-efficient method of preparation and the multiple applications of the composite material.

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Abstract

Biodegradable Laminated Composite Material Based on Cured Starch Foam and Method for Preparing it

There is provided biodegradable laminated composite material based on cured starch foam and a method for preparing it. During the preparation the starch foam is simultaneously combined with an additional layer of a further material. The advantages of the invention include the simple and cost-efficient method of preparation and the multiple applications of the composite material.

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Biodegradable Laminated Composite Material Based on Cured Starch Foam and Method for Preparing it

The invention relates to biodegradable laminated composite material based on cured starch foam and a method for preparing it.

Such composite materials can be used as packaging materials, as construction materials, for example, for cold, heat or sound insulation, or for shock absorption.

Conventional foam packaging materials made of polystyrene (Styrofoam), especially for food stuff, are problematic in particular in terms of their disposal. Such plastics virtually do not rot and can only be recycled after sorting.

In a known method a starch suspension is used in place of plastics. Liquid parts, once introduced in a heated die, evaporate and cause the suspension to foam or expand. The material remains in the mold over a particular dwell time for drying and curing while moisture escapes. Then the mold is released and the foam part ejected. Foam parts thus produced rot and are recyclable. Furthermore, they show cold- and heat-insulating as well as shock-absorbing properties. However, they have the drawback of exhibiting relatively low strength unless they are heavyweight or have fairly thick walls. Furthermore, they are not useful for

certain applications due to their porous surfaces, in particular it is difficult to print on them.

By contrast, the object underlying the present invention is to provide biodegradable laminated composite material characterized by high strength, a simple and cost-efficient method of preparation and multiple applications.

This object is achieved by providing the features indicated in the claims.

In achieving the object, the invention is based on the concept of foaming and curing starch to form a layer and simultaneously combining it with an additional layer of a further laminate material to obtain laminated composite material. Said further laminate material can be integrated into the starch foam and/or positioned adjacent to the foam uni- or bilaterally and serves as support, carrier or substrate.

The invention has the following advantages.

Starch can be used without further additives. A variety of materials can be combined with the starch foam to form laminated composite material. In particular, the laminated composite material, on account of said further laminate material, is easy to print on or dye. The laminated composite material is mechanically stable and exhibits excellent sound, temperature and electrical insulation properties due to the porosity of the cured starch foam. Furthermore, it is effective in absorbing shock. The invention can most advantageously be used as packaging material for sweets because the laminated composite material permits printing for publicity purposes and ensures shock absorption and heat insulation required for sweets.

The invention is further illustrated below.

The laminated composite material of the invention comprises at least a layer of cured starch foam combined with at least one further material to form laminated composite material. Preferably, said further material is flat material covered with starch foam preferably unilaterally.

The method of the invention is based on a starch suspension which may contain native and/or modified starch. The native starch may be of any origin in natural or hybrid form and derived, for example, from potatoes, manioc, rice, corn, wax corn, corn with high amylose content, grain such as wheat and fractions prepared therefrom, barley or sorghum. The modified starch is a physically and/or chemically produced starch derivative. Preferred are aqueous starch suspensions that may be mixed with dyes compatible with food stuff.

Furthermore, further laminate material is used in the method, which material preferably comprises paper, paperboard, cardboard, textiles, wood veneer, leather, imitation leather, films from synthetic, biopolymeric and metallic materials as well as combinations of the aforementioned materials. Preferably, said further laminate material is flat material. It is determined by the final form of the laminated composite material, such as packages, and can be introduced in the mold either as a blank or in preformed state. This preferably occurs shortly before the starch suspension is added.

The starch suspension is preferably introduced in the die by injection and in measured amounts. In the heated mold the suspension foams following evaporation and fills the cavities. During that time and during the drying and chemicophysical curing processes the starch is combined with the further laminate material to form a unit that is subsequently released from the mold as laminated composite material. These processes are promoted by the increased

internal pressure in the die and preferably conducted while controlling pressure and temperature.

It is surprising that the relatively high molding temperature does not affect the further laminate material when the method is conducted properly. This also applies for any printing done to the further laminate material, especially paper, paperboard or cardboard, prior to introduction in the die and subsequent deformation. In particular, if the starch suspension is applied to the further laminate material unilaterally, the print appears on one side of the laminated composite material upon release from the mold. In the case of unilateral application of the starch suspension, recycled cardboard material can be used for packaging food stuff which material does not come into contact with the food stuff at the outside of the packages.

To obtain several printable or smooth surfaces and to enhance strength, a plurality of layers of the further laminate material can be introduced in the die. In this case the starch suspension is mainly introduced between the layers of said further laminate material.

By proper design of the die, structures can be molded into the laminated composite material, such as, e.g., openings, cavities, webs or ribs. This might make sense for packaging and strength reasons. After removal from the die, the material can be further processed by deforming, stamping, punching and/or formating.

A preferred application of the method is the production of packaging material. In this case the further laminate material can be preformed to a packaging shell.

The combination of further laminate material and starch foam results in the finished articles having much higher strength than its individual components or addition thereof without

intimate bonding. The laminated composite material has low specific weight and relatively thin walls. Moreover, it exhibits considerably improved cold- and heat-insulating as well as shock-absorbing properties in comparison to conventional plastics and is antistatic.

The combination of, for instance, flat material and starch foam requires no additives such as hot or cold glue or plastics, etc. As a result, the laminated composite material can be easily recycled in addition to being biodegradable and compostable because it can be disposed of as monomaterial and at very low cost. In particular, if paper, cardboard or paperboard is used as the flat material, the laminated composite material can be recycled in the paper, cardboard or paperboard production.

The properties of the laminated composite material of the invention permit a multitude of applications other than packaging. For example, the material can be used in construction, electronics and the automobile manufacture for insulation purposes. Furthermore, it can be used for fashion articles having fairly high stability, such as furniture which must be recyclable due to their short life.

Using an example, the method of the invention will be described in more detail below.

In a continuous process a starch suspension is prepared wherein liquid and solid adjuvants are automatically measured, finely dispersed in a homogenization step and reacted. Potato starch, corn swelling starch and water are present in the suspension in a weight ratio of 100:5.2:106.

Furthermore, a temperature- and pressure-controlled expansion molding apparatus having a similar construction as a waffle iron and comprising a mold made of cast iron in the form of a packaging shell is heated to 220°C. The die of the

molding apparatus is made of two parts. A preformed shell is placed as flat cardboard material in the lower mold part. Then 21.5 g of starch suspension is poured into the shell and the two-part die is closed. The starch suspension is foamed, dried, cured and thereby solidly combined with the cardboard shell. After a dwell time of about 70 seconds, the finished packaging shell in the form of laminated composite material is removed.

The expansion molding apparatus can be rearranged for the production of a multitude of surface structures for plate-like laminated composite materials. This merely requires replacement of the mold made of cast iron. Thus, a variety of sorting devices for containers to store assortments of small parts (e.g., screws or small household articles) or to store pressure-sensitive and perishable food stuff (e.g., chocolates or eggs) can be produced, for example.

The shell has a specific weight of 190 kg/m^3 and excellent packaging properties. It combines high strength and low weight, exhibits cold- and heat-insulating, shock-absorbing and antistatic properties. It is readily biodegradable and compostable as well as excellently recyclable in the paper industry.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Laminated composite material comprising at least a foam layer and at least one additional layer of a material characterized in that the foam material is cured starch foam and the layers are biodegradable and interconnected in situ without a coupling agent.

2. Composite material as defined in Claim 1 characterized in that the starch foam contains native starch.

3. Composite material as defined in any of Claims 1 and 2 characterized in that the starch foam contains modified starch.

4. Composite material as defined in any of Claims 1 to 3 characterized in that the starch foam is dyed.

5. Composite material as defined in any of Claims 1 to 4 characterized in that the starch foam contains fibers and/or fillers.

6. Composite material as defined in any of Claims 1 to 5 characterized in that the additional layer is made of paper, paperboard, cardboard, textiles from natural and/or synthetic fibers and/or mixed fabrics, wood veneer, leather, sheets from synthetic and biopolymeric materials, films from synthetic and/or biopolymeric materials that are produced in situ in the preparation of the composite material, as well as combinations of the aforementioned materials.

7. Composite material as defined in any of Claims 1 to 6 characterized in that the additional layer is combined with the starch foam unilaterally.

8. Composite material as defined in any of claims 1 to 7 characterized in that the additional layer is or can be printed on.

9. Composite material as defined in any of claims 1 to 8 characterized in that the additional layer is composed of a plurality of layers.

10. Composite material as defined in claim 9 characterized in that the starch foam is positioned between the plurality of layers.

11. Composite material as defined in any of claims 1 to 10 characterized in that it is formed to a plate having cavities.

12. Composite material as defined in claim 11 characterized in that the cavities pressed in the plate form hollow spaces between stacked plates.

13. Packaging material comprising the laminated composite material as defined in any of claims 1 to 12 especially for use in packages for sweets.

14. A method for preparing laminated composite material as defined in any of claims 1 to 12 comprising the steps of:

a. introducing a starch suspension and at least one further laminate material in a die,
b. curing the starch foam and simultaneously combining it with said further material to form laminated composite material, and
c. removing said laminated composite material from the mold.

15. A method as defined in claim 14 characterized in that the die is heated prior to step a.

16. A method as defined in claim 14 or 15 characterized in that an aqueous starch suspension is added in step a.

17. A method as defined in claim 14, 15 or 16 characterized in that a dyed starch suspension is added in step a.

18. A method as defined in any of claims 14 to 17 characterized in that the starch suspension is injected in step a.

19. A method as defined in any of claims 14 to 18 characterized in that the starch suspension is pressure-foamed in step a.

20. A method as defined in any of claims 14 to 19 characterized in that the further material is added prior to the starch suspension in step a.

21. A method as defined in any of claims 14 to 20 characterized in that the further material is added as liquid and/or solid, powdery material and a layer is produced in step a, which layer combined with the starch foam forms the laminated composite material.

22. A method as defined in any of claims 14 to 21 characterized in that the further material is first preformed and then introduced in step a.

23. A method as defined in claim 22 characterized in that the further material is preformed to a shell.

24. A method as defined in any of claims 14 to 23 characterized in that a starch suspension comprising 20-45% of granular starch, 0-10% of swelling starch and water is added in step a, wherein the die is heated to a temperature of 180-270°C, preferably 200-250°C, and step c is taken after 30-90 seconds, preferably 45-75 seconds.

25. Use of the composite material as defined in any of claims 1 to 12 as sorting devices for containers for packaging goods, in particular chocolates, as foldable boxes or as padding to avoid transportation damage, as heat insulation packaging for frozen products or as cups for cold and hot drinks.